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THE RIVER-BANK VEGETATION OF THE LOWER APALACHICOLA, AND A NEW PRINCIPLE ILLUSTRATED THEREBY

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Every river is unique in some respects, and the Apalachicola, which is formed by the union of the Flint and Chattahoochee at the southwestern corner of Georgia, and flows in a general southerly direction to the Gulf, dividing West Florida from Middle Florida, seems to be more so than many others of similar size. Only one other river, the Alabama, carries water from the Piedmont region to the Gulf of Mexico, and the Apalachicola differs from that in several ways. In the first place, it has no connection with the Paleozoic region or the Cretaceous "prairie" region, and is therefore presumably less calcareous. Second, it flows through a very low and flat country* for the last sixty miles or so of its course, while the Alabama has rolling hills close to it all the way to its mouth† (and even beyond, for there are bluffs nearly 100 feet high on Mobile Bay).

Botanically also the Apalachicola presents many interesting features. On its eastern bank between the Georgia line and Bristol there are several high bluffs, which have been celebrated among botanists for three quarters of a century on account of being the home of two gymnospermous trees not known anywhere

* Described as the "Middle Florida flatwoods" in Ann. Rep. Fla. Geol. Surv. 3: 221–222. 1911.

† The railroad which crosses the estuarine swamps of the Apalachicola a few miles from its mouth, where they are five miles wide, goes on trestles all the way, presumably because the nearest hills from which earth could be obtained on a level with the cars are over 40 miles away; while the one which is similarly situated with respect to the Alabama River system crosses 15 miles of swamp, on earth embankments.

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else in the world, and a few other rare plants, as well as being the southern limit of quite a number of shade-loving species which are more common in the mountains a few hundred miles farther north.*

For nearly a quarter of a century geologists have been attracted to the same region by the splendid sections of certain Oligocene and Miocene formations exposed in these bluffs, some of which are over 150 feet high.† But the flat country between Bristol and the coast has been almost universally regarded by geologists as devoid of interest,‡ apparently because no fossils are found there. And except in the immediate vicinity of Apalachicola, at the mouth of the river, almost no botanical work has been done along the lower Apalachicola, perhaps chiefly because the flat country is very thinly settled and there are few accommodations for travelers along that part of the river.

Notwithstanding Drummond's botanical discoveries near Apalachicola in 1835,§ Dr. A. W. Chapman's residence there from 1847 to 1899, and the visits of several other botanists to the place during that period — all of whom must have traveled on the river in going or coming, for Apalachicola had no railroad until 1907 — no one hitherto seems to have thought it worth while to describe the vegetation observable from a boat on the lower portions of the river, and thus some significant and more or less important facts have never been brought to the attention of the public.

At noon on April 25, 1910, I embarked at Apalachicola on a commodious river steamboat bound upstream, and by nightfall

* See Gray, A pilgrimage to Torreya, Scientific Papers of Asa Gray 1: 188–196. 1889) Curtiss, Tenth Census U. S. 9: 521. 1884; Chapman, Bot. Gaz. 10: 251–254. 1885; Cowles, Rep. 8th Int. Geog. Cong. 599. 1905.

† See Sellards & Gunter, Ann. Rep. Fla. Geol. Surv. 2: 261–279. 1910; and several earlier papers there referred to. (On page 261, "middle west Florida" should read "western Middle Florida," and "from Gibson to Havana" [Florida] should be "near Fowlstown, Georgia." On page 266, "St. Andrews Bay" was evidently intended for Apalachicola Bay.)

‡ See E. A Smith, Tenth Census U. S. 6: 226, 241. 1884; W. H. Dall, Bull. U. S. Geol. Surv. 84: 95. 1892; Dall & Stanley-Brown, Bull. Geol. Soc. Am. 5: 150. 1894.

§ Comp. Bot. Mag. 1: 16. 1835; Sargent, Silva N. A. 7: 110. 1895.

had traveled about fifty miles, or some ten miles above the mouth of the Chipola River.* Notes on the river-bank vegetation were taken all the way in the usual manner, mostly from the pilot-house, about 25 feet above the water, which afforded an ample view in all directions.

Near the mouth of the river it is bordered by extensive marshes based on soft mud.† A little farther upstream strips and patches of trees begin to appear in the marshes, increasing in size and

FIG. 1. Looking down Apalachicola River near Smith's Bend, about 25 miles above Apalachicola, showing swamp vegetation extending to water's edge. A few specimens of *Pinus glabra* visible at right.

abundance until within a very few miles the marshes are reduced to narrow and more or less interrupted strips of reed-like vegetation at the water's edge, which gradually disappear entirely. The banks at the same time become firmer and higher, but in this lower portion of the river there are very few places that can be called bluffs, and the trees nearly everywhere grow right down to the water. From the boat it was difficult to form

* The Apalachicola seems never to have been carefully measured like some of the other navigable rivers of the South, so that it is impossible to give exact figures.

† See Ann. Rep. Fla. Geol. Surv. 3: 235. 1911.

any idea of the width of the swamps, there being no hills back of them.

No abrupt changes in vegetation or environmental conditions were noticed on this trip, but in order to bring out certain contrasts between the vegetation near the mouth of the river and that farther up I have divided my notes arbitrarily into two parts, selecting as the dividing point Owl Creek, which forms part of the boundary between Franklin and Liberty Counties, about thirty miles from Apalachicola by water.

In the following table the plants seen below Owl Creek and those seen above it are arranged in parallel columns, as was done with those of the Cretaceous and Eocene portions of the Warrior and Tombigbee Rivers last year.* The number prefixed to the name of each species indicates the number of times it was seen on that section of the river; those seen only once being omitted.

The country along the lower Apalachicola is so thinly settled that the effects of civilization on the river-bank vegetation, except for the removal of a good deal of *Taxodium distichum* by lumbermen, do not need to concern us at present. Almost the only works of man visible from a boat on this part of the river are lumber camps and a few apiaries, the latter being located there to take advantage of the abundance of honey furnished in spring by the two species of *Nyssa* listed below.†

The plants noted in the manner above described are as follows:

Below Owl Creek	Above Owl Creek
Trees	*Trees*
29 Taxodium distichum	42 Salix nigra
25 Salix nigra? ‡	22 Planera aquatica
18 Sabal Palmetto	22 Betula nigra
18 Nyssa uniflora	21 Liquidambar Styraciflua
17 Nyssa Ogeche	18 Taxodium distichum
8 Magnolia glauca	18 Nyssa Ogeche
8 Planera aquatica	14 Populus deltoides

* Bull. Torrey Club 37: 113–115. 1910.

† See Sargent, Silva N. A. 14: 101. 1902. Calhoun County, which forms the western bank of the river along the greater part of the route here described, is the banner honey county of Florida, producing annually about one-third of the crop of the whole state.

‡ Some of the willows seen in the first few miles may be another species which is widely distributed in Florida and passes at present for *S. longipes*.

6	Pinus Taeda	14	Platanus occidentalis
5	Pinus glabra	12	Acer rubrum?*
5	Liquidambar Styraciflua	11	Quercus nigra
3	Acer rubrum	8	Populus heterophylla
3	Quercus lyrata	7	Nyssa uniflora
3	Populus deltoides	6	Fraxinus caroliniana?
3	Betula nigra	5	Ulmus americana?
2	Fraxinus profunda?†	4	Quercus lyrata
		4	Magnolia glauca
		3	Sabal Palmetto
		2	Quercus Michauxii
		2	Hicoria aquatica
		2	Gleditschia sp.
		2	Carpinus caroliniana
		2	Acer saccharinum
	Shrubs		*Shrubs and Vines*
9	Alnus rugosa	24	Arundinaria macrosperma
2	Sabal glabra	14	Sabal glabra
		11	Vitis aestivalis?
		11	Wistaria frutescens
		8	Ampelopsis arborea
	Herbs	5	Brunnichia cirrhosa
22	Tillandsia usneoides	5	Phoradendron flavescens
4	Zizania palustris?	2	Itea virginica
4	Scirpus validus		
2	Cladium effusum		*Herbs*
2	Phragmites communis	19	Tillandsia usneoides
		6	Zizania palustris? ‡
		3	Senecio lobatus

Before discussing the significant features of this table it will be in order to explain a few facts which the table does not show.

The two pines mentioned in the first column did not grow immediately on the banks of the river, but a short distance back, presumably on ground elevated a trifle above the swamps. The same might be said of a few of the species in the second column, such as *Quercus nigra* and *Carpinus*. *Betula nigra* and *Acer saccharinum*, here as elsewhere, seemed to be confined to the immediate banks of the stream, leaning out over the water. *Salix*

* See notes on this species in Ann. Rep. Fla. Geol. Surv. 3: 322. 1911; also Bush, Gard. & For. 10: 516. 1897.

† Or more likely the var. *tridens*, which seems to enjoy more alluvial habitats than the typical *A. rubrum*.

‡ Without flowers I could not be sure whether this large grass was *Zizania* or *Zizaniopsis*.

nigra, especially in the portions of the river farthest from its mouth, where the tendency to meandering is greatest, was almost confined to the inside of bends, where deposition of sediment is taking place most of the time. *Nyssa biflora*, which is very common in the estuarine swamps near the mouth of the river,* was not seen at all on the banks, perhaps because the water there is a little too swift or too muddy for it.

In dividing the notes at only one point in this way there is nothing to show the reader just where each species was first and last seen. But of the species in the first column, *Nyssa uniflora*, *Planera*, *Quercus lyrata*, *Populus deltoides*, and *Betula* have not been observed in the typical estuarine swamps, and were not seen until after passing through the railroad bridge about four miles above Apalachicola. Of those in the second column, *Nyssa Ogeche*, *Populus heterophylla*, *Magnolia glauca*, *Sabal Palmetto*, and *Zizania* are not found in the alluvial swamps above Bristol,† and perhaps do not grow on the banks of the river anywhere above the point where darkness put an end to my observations, which must be about thirty miles below Bristol.

Sabal Palmetto extends sparingly up the river to a little above the mouth of the Chipola, far enough to overlap *Platanus*, *Betula*, *Planera*, *Populus heterophylla*, *Arundinaria*, *Wistaria*, and *Brunnichia*. (There is probably no other place in the world where it associates with all these alluvial swamp plants, or even half of them.) *Magnolia glauca* as a river-swamp tree extends at least five miles above the mouth of the Chipola, but apparently not far enough to meet *Acer saccharinum*, which was not seen until about sunset. *Nyssa Ogeche* extends a little farther up, meeting *Acer saccharinum* about fifty miles from the coast, and probably nowhere else.

Planera, *Betula*, and *Populus deltoides* were first noticed about fifteen miles above Apalachicola, and *Populus heterophylla*, *Platanus*, *Quercus nigra*, *Arundinaria*, *Wistaria*, *Vitis*, *Brunnichia*, and *Ampelopsis* at about twice that distance.

Salix nigra, *Platanus occidentalis*, both species of *Populus*,

* Described in Ann. Rep. Fla. Geol. Surv. 3: 235–237. *pl. 19, 2. f. 17.* 1911.

† Ibid., 234–235. *pl. 19, 1.* 1911.

Nyssa Ogeche, *Acer saccharinum*, *Arundinaria macrosperma*, *Wistaria*, and *Brunnichia* probably extend farther south on this river than in any other part of their ranges; and several of these are not known on any other stream in Florida.*

Now for the interpretation of some of the returns shown in the table. On comparing the two lists it will be seen that herbs and evergreen trees (particularly *Sabal Palmetto* and *Magnolia glauca*) are more abundant in the lower portions of the river, and species of woody plants more numerous farther up, all of which seems to indicate that the vegetation near the mouth of the river is farther removed from the climax condition than that higher up. (Such statistics would not carry much weight if based on this one day's work alone, but I have observed similar relations on several other rivers.) Looking at the matter more closely from a floristic standpoint, *Fraxinus profunda*, *Alnus*, *Scirpus*, *Cladium*, and *Phragmites* were not seen at all after passing Owl Creek, and *Taxodium*, *Sabal Palmetto*, *Nyssa uniflora*, and *Magnolia glauca* were noticeably more abundant below there than above. On the other hand, *Platanus*, *Quercus nigra*, *Populus heterophylla*, *Ulmus americana*, *Gleditschia*, *Hicoria aquatica*, *Quercus Michauxii*, *Carpinus*, *Acer saccharinum*, *Arundinaria*, *Vitis*, *Wistaria*, *Ampelopsis*, *Brunnichia*, and *Itea* were not identified below Owl Creek, and *Salix nigra*, *Planera*, *Betula*, *Liquidambar*, *Populus deltoides*, *Fraxinus caroliniana*, *Sabal glabra*, and *Phoradendron* were seen considerably oftener in the second part of the journey than in the first, although the first was a little longer.

The explanation of all these differences between the vegetation near the mouth of the river and that a little farther up must be sought in one or more environmental or historical factors. The environmental differences between the two portions are of several kinds, among which may be enumerated the following:—

1. The upper reaches of the river, being farther north, presumably have a slightly cooler climate. But in such a short distance climatic differences due to latitude would hardly be

* *Salix nigra*, *Acer saccharinum*, both species of *Populus*, *Nyssa uniflora*, *Quercus lyrata*, *Betula*, and *Planera* are not mentioned in the most complete list of Florida plants extant, namely, that of Prof. A. S. Hitchcock in Trans. Kan. Acad. Sci. 16: 108–157. 1899; 17: 79–105. 1901.

perceptible, and some of the species confined to the second column (*e. g.*, *Arundinaria*, *Brunnichia*) are more "tropical" than some of those confined to the first (*e. g.*, *Alnus*, *Scirpus*, *Phragmites*).

2. The proximity of the Gulf of Mexico to the lower portions of the river might affect the climate there by making the summers more humid, or the winters milder, or both. Although this might perhaps be assumed to have something to do with the distribution of *Sabal Palmetto* or *Platanus*, it would not explain the abundance coastward of *Taxodium*, *Magnolia*, and *Alnus*, for those are equally at home much farther north and farther inland. Besides the differences due to this cause, like the first, would be very slight.

3. The water near the mouth of the river is of course a little more salty, and more affected by tides, than that farther up. But none of the plants in the first column are believed to have any particular fondness for salt, with the possible exception of *Sabal Palmetto* (whose habitat preferences are still a puzzle) and two or three of the herbs; and nearly all of them are common far inland, where there is no tide.

4. The farther one goes up the river, the higher and firmer the banks become. It may be that *Betula*, *Quercus Michauxii*, *Acer saccharinum*, and a few other trees require a solid footing, but many of the species which are abundant on the soft muck of the estuarine swamps grow just as well or even better on *terra firma* in the interior.

5. This region, like many other parts of the coastal plain, is supposed to have been submerged beneath the sea in comparatively recent times, geologically speaking, and of course the mouth of the river emerged last, which would tend to make the vegetation there more nearly of the pioneer type, if other things were equal. But we know too little as yet of the effects of geological history on vegetation, and besides, the region under consideration is so nearly level that it must have all emerged from beneath the waves almost simultaneously. If the plants along this river were not known anywhere else, then it would be difficult to separate the effects of history from those of some other factors, especially the one next to be described. But nearly all

the species in the first column are common enough at considerably higher altitudes, which have not been submerged for ages. That some of the species in the second column have not yet had time or opportunity to spread southward or coastward as far as the mouth of the river is still less likely.

6. All streams, the large muddy rivers especially, are subject to seasonal variations in volume. In times of flood every river at every point in its course must either rise (so as to increase the area of its cross-section), or flow faster, or both. But no flood can raise the level of the ocean appreciably; so the mouths of rivers are practically free from seasonal changes of level, and fluctuate only with the wind and tides. And these influences are comparatively slight at Apalachicola, which is protected by a barrier beach a few miles off shore.

The amount of seasonal fluctuation in any river of course increases upstream, to a certain point where the diminishing volume of water (or in some cases the greater slope of the channel) begins to offset it. (In the case of the Apalachicola River system the point of maximum fluctuation is far north of the portion under consideration, probably near the fall-line.) As the Florida portion of this river is navigable all the year round, it has not yet been considered necessary to measure its fluctuations, but making a rough estimate I should say that at the point where this excursion terminated the water varies in level about ten feet during the year.

There are doubtless other environmental factors concerned to some extent in the problem, but those discussed above seem to be most significant, and the last one by far the most important. All the available evidence seems to point to the conclusion that most of the swamp plants confined to the more inland portions of this and similar rivers simply require (or tolerate?) more seasonal fluctuation of water than do those of the estuarine swamps, and *vice versa*. In the last few years I have observed similar correlations between pioneer vegetation and constant water-level in so many other places, both on the coast and in bogs and non-alluvial swamps in the interior, that I am inclined to regard this principle as of universal application, at least in temperate and

moderately humid climates (which are the only climates I have thus far experienced). Just how and why fluctuations of water-level affect vegetation is a problem which belongs to ecology rather than to phytogeography, and it would require too much space to discuss it here.

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FOSSIL FLOWERS AND FRUITS

BY T. D. A. COCKERELL

The Miocene shales at Florissant, Colorado, are remarkably rich in flowers and fruits, some of which have already been described. Many others have remained unpublished, because I found it extremely difficult to determine their generic relationships with any degree of certainty. Some years ago, I took a series to Cambridge University in England, where they were much admired, but eventually returned to me with the remark that no one there felt able to describe them. I have been very unwilling to publish species of "*Antholithes*," "*Carpolithes*," etc., which could not even be referred definitely to particular families; but it is possible that by ignoring these specimens we may be missing some important evidence. Tertiary plants are nearly always referred to living genera, and it is at least certain that few if any distinct genera of plants have originated since the Miocene. It is quite a different question, however, whether any have become extinct since that time, and indeed it is practically certain that many genera have disappeared during the Tertiary. We know genera like *Sequoia*, which formerly were widespread and abundant, but now are restricted to small areas. The important genus *Ginkgo* would have disappeared entirely had it not been taken into cultivation. It is therefore quite reasonable to look for extinct genera in the Miocene, and if these really exist among our fossils, it is probable that the fruits and flowers will best indicate them. For such reasons as these it may be worth while to publish descriptions of unclassified flowers and fruits, which may be introduced as "*Antholithes*" and "*Carpolithes*," and perhaps correctly classified at some later date.